VERIFICATION OF TRANSLATION

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declare that I am well acquainted with both the Japanese and English languages, and that the attached is an accurate translation, to the best of my knowledge and ability, of JP Application No. 2003-424672, filed December 22, 2003.

I further declare that all statements made herein of my knowledge are true and that all statements made on information and belief are believed to be true; and, further, that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such wilful false statements may jeopardize the validity of the above-captioned application or any trademark issued thereon,

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【Claim 1】

A carrier for a developer characterized by comprising spherical ferrite particles having an average particle size of 20 to 50 μm, a surface uniformity of 90% or more, an average sphericity of 1 to 1.3, and a sphericity standard deviation of 0.15 or less.

【Claim 2】

The carrier for a developer according to claim 1, wherein the particles have an apparent density of 2.0 to 2.5 g/cm^3, a magnetization of 40 to 80 Am^2/kg in a magnetic field of 79.5 A/m, and a scattered material magnetization of 80% or more of a main body magnetization.

【Claim 3】

A developer comprising the carrier according to claim 1 or claim 2 and a toner.

【Claim 4】

A process for producing a carrier for a developer, the process comprising the sintering of the fluidized ferrite particle performed at a sintering temperature of 1,200°C or more and the coating of an organic resin on the ferrite particles.

【Document Name】Specification

【Title of The Invention】

Carrier for developer, developer comprising the carrier and process for producing the carrier

【Technical Field】

[0001]

The present invention relates to a carrier for developer having a specific property, a developer comprising the carrier and a process for producing the carrier.

【Background Art】

[0002]

The developer with high durability which can provide a high quality photograph and a printed matter is required in the market. The response of the corresponding industry to such requirements in the market is reduction of the particle size of a toner and/or carrier.

[0003]

Regarding toners, various toners having small particle sizes and sharp particle size distributions by polymer toner technologies, etc., have been proposed. On the other hand for a carrier, a carrier of a small particle size is proposed to perform high quality printed image.

[0004]

When the particle-sized of a carrier is made small, a formed magnetic brush is made soft, and the specific surface

area of the carrier is made large and amount of the held toner is made large. As a result, large effects on image qualities such as the image density, fogging in printed image, toner scattering and gradation has been achieved.

[0005]

In addition, the surface of the core material (ferrite particle) may be coated with various kind of resin for improvement of the durability. However, it is difficult to maintain the shape of the small particle sized ferrite spherical which is effective for high quality printed image. As a result, the coating nonuniformity and exposed parts of the core material are generated at the time of resin-coating because the sphericity of the small particle sized ferrite is low. Thus, the carrier performance is not fully achieved, and the high-quality printed image and the elongated life (high durability) required for developers are not accomplished by now.

[0006]

Further, even the technology described below is disclosed as the technical proposal and approach objecting the high-quality printed image and the elongated life is attempted, the technology is not satisfactory yet.

[0007]

The carrier disclosed in Patent Document 1 (Japanese Patent Laid-Open No.07-98521) specifies a 50% average particle size (D_{50}) of 15 to 45 μm and a content ratio for identical particle size. In addition, even a parameter to

determine a particle shape is specified according to a specific surface area measured by air penetration methods, but the shape is indicated in just an average value, so, it is not sufficient.

[0008]

The carrier disclosed in Patent Document 2 (Japanese Patent Laid-Open No.2001-117285) comprises a carrier particle (core material) having a volume average particle size of 25 to 50 μm and a volume resistance of 10^6 to 10^{10} Ohm*cm. In addition, it specifies a uniformity of the particle surface by using the BET specific surface area, but the shape is also indicated in just an average value as same as the document above, so, it is not sufficient.

[0009]

The developer disclosed in Patent Document 3 (Japanese Patent Laid-Open No.08-292607) specifies shape factors on both core material and the core material after forming resin-layer, but the shape is indicated in just an average value, so, it is not sufficient also.

[0010]

The carrier disclosed in Patent Document 4 (Japanese Patent Laid-Open No.09-197722) comprises an average particle size of 30 to 40 μm, a saturation magnetization of 50 to 70 Am^2/kg and a weight ratio of not more than 22 μm of 2.0 to 17.0 wt%. In addition, a particle shape is specified to be "shape factor of the particles bigger than average particle size" < "shape factor of the particles smaller than average

particle size", but it is difficult to perform required properties because a shape of the particle is not made clear enough.

[0011]

Further, the ideas to indicate a shape of the core material and the carrier with a number of a shape factor are proposed. Anyhow, the shapes are indicated in an average values, so, it is concluded that to improve performances more and more, distribution of the shape should be considered.

[0012]

Next, it was made clear that even the shape factor of the core material and the standard deviation of it may be specified, in the resin coating, performances of the resin coated carrier differs how the surface of the core material uniform or not.

[0013]

Patent Document 5 (Japanese Patent Laid-Open No.2002-139898) proposes to point out a coefficient of variation which shows distribution of the shape factor. Background of the proposal is to make attention on the transportability of the developer, i.e. uniformity in the shape and the particle size may stabilize fluidity. However, the proposal is made on irregular shaped carrier such as magnetic powder dispersed-type carrier. It means that it is different from the present invention which performs resin coating on the ferrite core material. In addition, it may be a special developing system because as obviously described

in the Examples, magnetic property is about $15Am^2/kg$ and the particle size is almost 15 micron-meter. Such a carrier has advantage in that it enables magnetic brush soft to reduce stress on the toner and prevent bonding of the toner onto the carrier and/or other devices, but has drawback in capacity to provide tribo-electric to the toner. As a result, it is difficult to apply high-speed machine, i.e. capacity of developing in wide range of machine speed.

[0014]

Patent Document 6 (Japanese Patent Laid-Open No.02-255539) discloses that magnetic properties are improved by the spherical ferrite powder with particle diameter of 10 to 100 micron-meter which is made to be a magnetic resin molds. However, average sphericity with a standard deviation of it and surface uniformity of the ferrite particles are not disclosed, and cannot satisfy requirement for the high-quality printed image and the elongated life.

[Patent Document 1]: Japanese Patent Laid-Open No.07-98521

[Patent Document 2]: Japanese Patent Laid-Open No.2001-117285

[Patent Document 3]: Japanese Patent Laid-Open No.08-292607

[Patent Document 4]: Japanese Patent Laid-Open No.09-197722

[Patent Document 5]: Japanese Patent Laid-Open No.2002-139898

[Patent Document 6]: Japanese Patent Laid-Open No.02-255539

【Disclosure of the Invention】

【Object of the Invention to be solved】

[0015]

The object of the present invention is to provide a carrier for a developer which can provide elongated life to a developer and a high quality on a photograph and a printed matter, a developer comprising the carrier and a production method of the carrier.

【Means For Solving Problem】

[0016]

As a result of the intensive investigation on the problems described above, the present inventors have found out that the above object can be achieved by using the carrier comprising specific properties and the present invention was completed.

[0017]

That is, the present invention provides a carrier for a developer comprising spherical ferrite particles having an average particle size of 20 to 50 μm, a surface uniformity of 90% or more, an average sphericity of 1 to 1.3 and a sphericity standard deviation of 0.15 or less and the particles are coated with an organic resin.

[0018]

In the above resin-coated carrier, the above spherical ferrite particles have an apparent density of 2.0 to 2.5 g/cm^3, a magnetization of 40 to 80 Am^2/kg in the magnetic field of 79.5 A/m, and a scattered material magnetization 80% or more of a main body magnetization.

[0019]

The present invention also provides a developer comprising the carrier and a toner. In addition, the process for producing a carrier for a developer characterized in that the process comprising the sintering of the fluidized ferrite particle performed at a sintering temperature of 1,200°C or more and the coating of an organic resin on the ferrite particles.

【Effect of the Invention】

[0020]

When the carrier for a developer comprising the specific properties described above is used, a high quality on a photograph and a printed matter is obtained. In addition, the elongated life is provided to the developer to perform a high quality on a photograph and a printed matter even after a long term operation.

【Best Mode for Carrying Out the Invention】

[0021]

Hereinafter, the best mode for carrying out the present invention will be described.

A ferrite has advantage in that the shape is more spherical than an iron powder and magnetic properties can be controlled. However, as the ferrite is a kind of ceramics, there is drawback that a ferrite is superior in hardness but is easily broken by the given shock after ferrite forming reaction. In addition, when a particle size is made small, gaps among the particles will be closer to cause bonding of particles in the high temperature heating and it may make keeping of spherical shape hard.

[0022]

In addition, when the shredding process following to sintering process is provided to make the particles apart, too strong shock for shredding may result some broken particles to contaminate irregular shaped particles. That is, it may result poor quality printed image caused by uneven coating on the irregular shaped particles and/or poor fluidity, because an irregular shaped particles may be hard to separate from and such particles may be directly resin-coated in the next process.

[0023]

To maintain a spherical shape, sintering temperature can be reduced to prevent bonding of the particles. However, the obtained core materials may tend to be porous and the resin will penetrate into body of the particles in the process coating resin on the surface of the core material and may make deviation of the carrier properties big.

[0024]

As described above, in the process to perform ferrite forming reaction at a high temperature of 1200 deg.-C or more, technology to produce a small size ferrite particle which is spherical and excellent in the surface uniformity has been not sufficient.

[0025]

In the conventional method to sinter a ferrite, the raw material is filled in a sagger made of an alumina and the like and then sintered in the tunnel-type furnace. However, when the particle size is reduced, sintering temperature cannot be fully elevated because bonding between the particles may occur, and it results deviation in the surface uniformity. Such phenomenon may be the noise for forming of even coating in the next resin coating process and may deteriorate performance.

[0026]

In addition, to produce the spherical ferrite particles economically, classification is required after granulating, so, the granules should contain organic substances, a binder, an additives and the like. However, too much organic substances contained in the granules tends to be a reducing gas in the sintering process and affect to make sintering of the ferrite poor. So, such an organic substance is recommended to be removed before sintering at high temperature.

[0027]

In the high temperature sintering, sintering of fluidized granules for the purpose to prevent bonding of particles and sinter to make particle surface uniform may enable to produce good spherical ferrite particles.

[0028]

When the particles are evenly heated up, not only uniform surface on the particles but also even ferrite forming reaction can be achieved. As a result, distribution of the magnetic properties is made sharp and flexibility for the carrier scattering which may be a drawback in the small particle size carrier may be enhanced.

[0029]

As for practical method for producing the carrier of the present invention, ferrite granules are prepared by using a metal oxides, the prepared granules are put into a rotating sintering furnace (for example, rotary kiln and the like) to fluidize the ferrite granules in sintering at elevated temperature of 1200 deg.-C or more, the obtained sintered material is crushed and classified into a recommended particle size distribution, followed by coating an organic resin onto surface of the particles and the like can be exemplified.

[0030]

As described above, the fluidized ferrite particles are sintered in the rotary sintering furnace at the temperature of 1200 deg.-C or more, particles with uniform surface without bonding of particles can be obtained. However, fluidization mean is not limited to rotation and any methods which can

fluidize the ferrite particles can be applicable. Figure 1 shows illustrative diagram of a sintering step used in the present invention. As for symbols in the figure 1, 1 is a granules feeding apparatus, 2 is a rotary kiln, 3 is a hot section, 4 is a heater, 5 is a cooling section, 6 is a cooling medium and 7 is a sintered material. Figure 2 shows an electron microscope photograph (magnification of × 300) of a sintered material obtained by the sintering method of the present invention.

[0031]

The sintering temperature of fluidized ferrite particle is 1,200°C or more, preferably 1,200 to 1,400°C, more preferably 1,250 to 1,350°C. The sintering time is 0.1 to 10 hrs, preferably 0.1 to 8 hrs, more preferably 0.1 to 6 hrs.

[0032]

The granules may be pre-sintered before sintering of ferrite particles with fluidizing at the sintering temperature of 1200 deg.-C or more. The temperature of the pre-sintering may be 500 to 700 deg.-C lower than the sintering temperature. In the pre-sintering, the granules may or may not be made to fluidize. In the case of making the granules fluidize, a rotating sintering furnace as the fluidizing means is used as in sintering. The pre-sintering time may be 0.1 to 5 hrs, preferably 0.1 to 4 hrs, more preferably 0.1 to 2 hrs.

[0033]

As for crushing after sintering process, when particles are sintered in the manner filled in a sagger, particles may bond each other to result blocked material and it makes crushing hard. However, sintering is performed in the rotating sintering furnace and the like to fluidize the particles, bonding each other of the particles may be reduced and it may ease crushing. As the ferrite is weak against to the shock like a ceramics, when stress given in the crushing process is too much, breaking and/or cracking may be occur. So, it is very important to minimize stress in the crushing process.

[0034]

After crushing followed by classification into a recommended particle size distribution, surface of the particles are covered with an organic resin. The coating amount of the organic resin is not specially limited but it may be 0.1 to 4.0 wt%, preferably 0.5 to 3.0 wt%.

[0035]

As for the coating resin, various kinds of resins conventionally known are applicable with consideration of toner type. They include, for example, one or two or more of mixture selected from polypropylene, polystyrene, acrylic resin, poly acrylonitrile resin, strait silicone resin and a modified silicone resin, polyester resin, fluororesins such as poly-tetra fluoro ethylene and poly-fluoro vinylidene, poly-carbonate resin and epoxy resin.

[0036]

A method for coating a resin is not specially limited, but fluidized bed coating method and dip coating method can be exemplified. However, it should be reminded that according to the particle size reduction, gathering of the particles may easily happen.

[0037]

The developer will be prepared by mixing thus produced carrier and a toner. The developer could be a developer composed of one element or two or more elements. The developer of the present invention can be used for developing of a photograph and/or printing, especially, developing of an electric photograph and/or an electric printing.

[Example 1]

[0038]

Iron oxide (50 mol%), manganese oxide (40 mol%) and magnesium oxide (10 mol%) based on a total amount of oxides were weighed, mixed and crushed to obtain a crushed material; thereafter water of 25 L was added to an attritor; and the crushed material was further crushed for 1 h to prepare a slurry of a solid content of 50%. The prepared slurry was granulated by a spray drier to obtain spherical granules.

[0039]

The granules were calcined in a rotary kiln at 900°C. After the calcination, 20 kg of the granules, 20 L of water, 128 g (10% solution of polyvinyl alcohol) of a binder and 100 g (ammonium polycarboxylate) of a dispersant were together

crushed in an attritor for 2 hrs to obtain slurry having a solid content of 50%. The fabricated slurry was granulated by a spray drier to obtain spherical granules of 38 μm in average particle size.

[0040]

The granules were pre-sintered in a rotary kiln at 700°C for 0.5 hrs to remove organic substances such as the binder. Then, the pre-sintered granules were fed to a rotary kiln whose hot section was set at 1,320°C to further sinter for 1.5 hrs. In the sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% is fed at a flow rate of 50 L/min to the rotary kiln. The operating conditions and the feeding amount of the ferrite granules are as follows.

[0041]

The retort rotation speed of the rotary kiln: 3 rpm.

The retort inclination of the rotary kiln: 0.5°.

The feeding amount of the ferrite granules to be sintered: 3 kg/hr.

The inlet hammering frequency: 30 Times/Minuit

The outlet hammering frequency: 20 Times/Minuit

After the sintering, the obtained sintered material was shredded in a jet mill, and classified to obtain spherical ferrite particles of 35 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1.

[0042]

An acryl-modified silicone resin (KR-9706 (trade name)), manufactured by Shin-Etsu Chemical Co., Ltd., was diluted in toluene; and the above spherical ferrite particles (ferrite core material) were coated with the obtained dilution in an amount of 0.5 wt% using a fluidized bed coating apparatus, thereafter baked at 230°C for 1 hr, cooled, and shredded to obtain a resin-coated carrier. Evaluations by actual machines were conducted using the obtained resin-coated carrier. The results will be shown in Table 2.

[Example 2]

[0043]

The slurry having a solid content of 50% was obtained as in Example 1, and then spherical granules of 27 μm in average particle size were obtained by a spray drier. The granules were pre-sintered in a rotary kiln at 700°C for 0.5 hrs to remove organic substances such as the binder. Then, the pre-sintered granules were fed to a rotary kiln whose hot section was set at 1,320°C, and further sintered for 1.5 h. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed to the rotary kiln at a flow rate of 50 L/min. The operating conditions of the rotary kiln and the feeding amount of the ferrite granules were similar to Example 1.

[0044]

The retort rotation speed of the rotary kiln: 3 rpm.

The retort inclination of the rotary kiln: 0.5°.

The feeding amount of the ferrite granules to be sintered: 3 kg/hr.

In the sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed into the rotary kiln at a flow rate of 50 L/min. Then, obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 25 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. After the above obtained spherical ferrite particles (ferrite core material) were coated with a resin as in Example 1, evaluations by actual machines were conducted using the obtained resin-coated carrier as in Example 1. The results will be shown in Table 2.

[Example 3]

[0045]

The slurry having a solid content of 50% was obtained as in Example 1, and then spherical granules of 38 μm in average particle size were obtained by a spray drier. The granules material without pre-sintering, were directly sintered in a rotary kiln set at 1,320°C for 0.5 hrs. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 15% was fed to the rotary kiln at a flow rate of 50 L/min. After the sintering, the obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 35 μm in average particle size. The

results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. After the above obtained spherical ferrite particles (ferrite core material) were coated with a resin as in Example 1, evaluations by actual machines were conducted using the obtained resin-coated carrier as in Example 1. The results will be shown in Table 2.

[0046]

(Comparative Example 1)

After preparing granules by using a spray drier as in Example 1, the granules were charged with a sagger, and sintered in a tunnel-type electric sintering furnace at a sintering temperature of 1,310°C for 5 h. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed to the tunnel-type electric sintering furnace at a flow rate of 90 L/min. After the sintering, the obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 35 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. After the above obtained spherical ferrite particles (ferrite core material) were coated with a resin as in Example 1, evaluations by actual machines were conducted using the obtained resin-coated carrier as in Example 1. The results will be shown in Table 2.

[0047]

(Comparative Example 2)

The granules prepared as in Example 2 were pre-sintered in a rotary kiln at 700°C to remove additives such as a binder. Next, as in Comparative Example 1, the sintered granules were charged with a sagger, and further sintered in a tunnel-type electric sintering furnace at a sintering temperature of 1,310°C. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed to the tunnel-type electric sintering furnace at a flow rate of 50 L/min. After the sintering, the obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 25 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. After coating resin on the above obtained core particles as in Example 1, evaluations by actual machines were conducted using the obtained resin-coated carrier as in Example 1. The results will be shown in Table 2.

[0048]

(Comparative Example 3)

The granules prepared as in Comparative Example 2 were charged with a sagger, and sintered in a tunnel-type electric sintering furnace at a sintering temperature of 1,250°C. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed to the tunnel-type electric

sintering furnace at a flow rate of 90 L/min. After the sintering, the obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 25 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. After the above obtained spherical ferrite particles (ferrite core material) were coated with a resin as in Example 1, evaluations by actual machines were conducted using the obtained resin-coated carrier as in Example 1. The results will be shown in Table 2.

[0049]

(Comparative Example 4)

The granules prepared in Example 1 were fed to a rotary kiln whose hot section was set at 1,150°C for sintering. In sintering, a nitrogen-mixed gas adjusted to an oxygen concentration of 4.5% was fed to the rotary kiln at a flow rate of 50 L/min. The operating conditions of the rotary kiln and the feeding amount of the ferrite granules will be shown below.

[0050]

The retort rotation speed of the rotary kiln: 3 rpm.

The retort inclination of the rotary kiln: 0.5°.

The feeding amount of the ferrite granules to be sintered: 3 kg/hr.

After the sintering, the obtained sintered material was shredded by a jet mill, and classified to obtain spherical ferrite particles of 35 μm in average particle size. The results obtained by the measurements described later of the physical properties such as shape and sphericity of the spherical ferrite particles will be shown in Table 1. An acryl-modified silicone resin (KR-9706 (trade name)), manufactured by Shin-Etsu Chemical Co., Ltd., was diluted in toluene; and the above spherical ferrite particles (ferrite core material) were coated with the obtained dilution in an amount of 0.5 wt% using a fluidized bed coating apparatus, thereafter baked at 230°C for 1 hr, cooled, and shredded to obtain a resin-coated carrier. Evaluations by actual machines were conducted using the obtained resin-coated carrier. The results will be shown in Table 2.

[0051]

[Property evaluations of core material (ferrite particles)]

1. Average particle size:

The average particle size was measured using a laser diffraction-type particle size distribution measuring instrument "HELOS SYSTEM", manufactured by Japan Laser Corp.

[0052]

2. Apparent density (AD):

The apparent density was measured according to JIS-Z2504 (Metallic powders-Determination of apparent density-Funnel method).

[0053]

3. Surface uniformity:

(1) A core material was took photograph by a SEM (scanning electron microscope) at a magnification of × 200 by shifting the sight to count total number of more than 200 particles.

(2) The core material whose surface has a smooth part occupying a half or more of the surface is visually checked.

(3) One hundred particles of the core material are checked, and the percentage content of the core material shown in the above (2) is calculated.

[0054]

4. Average sphericity and sphericity standard deviation:

(1) A core material is photographed by a SEM at a magnification of × 300 by shifting the visual field so that the total number of more than 100 particles can be counted.

(2) SEM images are read by a scanner; the image analysis is conducted using an image analyzer soft (Image-Pro PLUS, manufactured by Media Cybernetics Inc.); and the circumscribed circle diameter and the inscribed circle diameter of each particle are determined, and the sphericity is let denote the ratio. If the two diameters are equal, the ratio is 1, and in the case of a true sphere, the ratio is 1.

(3) The average sphericity and its standard deviation are calculated from the sphericities determined for 100 particles.

[0055]

5. Saturation magnetization:

The magnetization was read in a magnetic field of 238.7 kA/m by a direct current magnetization property automatic recording instrument (BHU-60, manufactured by Riken Denshi Co., Ltd.) (Unit: Am^2/kg).

[0056]

6. Scattered material magnetization:

(1) Before a core material is set on a magnetic brush, the above magnetization of the core material (main body magnetization) was measured in a magnetic field of 79.5 A/m by a vibration-type magnetization measuring instrument VSM (manufactured by Toei Kogyo Co., Ltd.).

(2) The core material of 500 g was set on the magnetic brush, and forcibly made to scatter from the magnetic brush by rotating the magnetic brush at a rotation speed of 250 rpm for 5 min.

(3) Then ,the scattered core material was collected, and measured for the magnetization in a magnetic field of 79.5 A/m by the vibration-type magnetization measuring instrument VSM (manufactured by Toei Kogyo Co., Ltd.) to compare with the main body magnetization (unit: Am^2/kg).

[0057]

[Toner preparation]

A polyester resin obtained by condensing propoxylated bisphenol and fumaric acid of 100 parts by weight, a phthalocyanine pigment of 4 parts by weight and a chromium complex of di-tert-butyric acid of 4 parts by weight as raw materials were fully pre-mixed by a Henschel mixer, and melted and kneaded by a biaxially extruding kneader; and the obtained

kneaded material was cooled, thereafter coarsely pulverized into about 1.5 mm by a hammer mill, and then finely pulverized by a jet mill to obtain a fine pulverized material.

[0058]

Further, the obtained fine pulverized material was classified to obtain a cyan powder having a weight average particle size of 8.6 μm. 100 parts by weight of the powder prepared and 1 part by weight of titanium oxide of 0.05 μm in average particle size were mixed by a Henschel mixer to obtain a cyan toner 1.

[0059]

[Evaluations by actual machines]

Each resin-coated carrier and the cyan toner 1 fabricated as described above were mixed such that the toner concentration [(toner weight/developer (toner and carrier) weight) × 100] = 8% to fabricate a developer, which was charged with a developing machine, and set on the body of a full-color copier "ARC-160 (trade name)", manufactured by Sharp Corp., (the developer filling amount was 630 g). The printed image quality evaluations of sheets at an early stage of copying (the first sheet to the 13th sheet) and one hundred thousandth sheet were conducted by the methods described below to evaluate each developer.

[0060]

(1) Image density

Copying was performed under an optimum exposure condition to evaluate the ID (image density). The image densities of

the solid part were measured by a densitometer X-Rite (registered trade name, manufactured by Nippon Lithograph Inc.), and ranked as follows.

E: very excellent

G: in the range of a target image density

M: rather slightly low in image density, but usable

P: below a target lower limit

VP: very low in image density, and unusable

[0061]

(2) Fogging in printed image

A paper pace (a value for a paper before copying) was previously measured using the X-Rite (registered trade name) as in the image density measurement; the white ground after the copying was measured; and the fogging in printed image was determined by the expression: "the density after copying" - "the paper base" = fogging. Rank described in Table 2 will be shown as follows.

E: less than 0.5

G: 0.5 to 1.0

M: 1.0 to 1.5

P: 1.5 to 2.5

VP: 2.5 or more

[0062]

(3) Carrier scattering

Ten sheets were copied in letratone in an early stage copying and after copying of one hundred thousand sheets of A3 paper, respectively; and the number of white spots in the

ten sheets was counted. Rank described in Table 2 will be shown as follows.

E: no white spots

G: 1 to 5 spots

M: 6 to 10 spots

P: 11 to 20 spots

VP: 21 or more spots

[0063]

(4) Toner scattering

The toner scattering around the developing machine was visually confirmed. Rank described in Table 2 will be shown as follows.

E: not at all observed

G: confirmed to be in a quite small amount

M: on a limit (usable) level

P: much

VP: remarkably much

[0064]

(5) Horizontal narrow line reproducibility

The horizontal narrow line reproducibility was visually judged. Rank described in Table 2 will be shown as follows.

E: very excellently reproduced

G: almost reproduced

M: on a limit (usable) level

P: remarkably disconnected and blurred

VP: not at all reproduced

[0065]

(6) Half tone uniformity

The copied half tone was visually judged. Rank described in Table 2 will be shown as follows.

E: very uniform and no unevenness

G: uniform and no unevenness

M: slightly uneven, but on a limit (usable) level

P: remarkably uneven and nonuniform

VP: very much uneven and nonuniform

[0066]

[Table 1]

Example · Comparative Example	Average particle size (μm)	Apparent density (g/cm^3)	Surface uniformity (%)	Average sphericity (%)	Sphericity standard deviation	Saturation magnetization (Am^2/kg)	Scattered material magnetization (Am^2/kg)	Scattered material / main body (%)
Example 1	35	2.35	96	1.17	0.1137	60	56	93
Example 2	25	2.21	92	1.21	0.1246	60	54	90
Example 3	35	2.15	90	1.29	0.1434	50	44	88
Comparative Example 1	35	2.26	75	1.26	0.1666	61	40	66
Comparative Example 2	25	2.21	80	1.23	0.1707	62	45	73
Comparative Example 3	25	2.15	71	1.31	0.1771	63	41	65
Comparative Example 4	35	1.87	7	1.18	0.1134	64	56	88

[0067]

[Table 2]

	Item	Example 1	Example 2	Example 3	Comparative Example 1	Comparative Example 2	Comparative Example 3	Comparative Example 4
Early stage	Image density	E	E	G	G	M	M	M
	Fogging in printed image	E	E	G	M	M	P	VP
	Toner scattering	E	E	G	M	M	M	M
	Carrier scattering	E	G	M	M	VP	P	P
	Horizontal narrow line reproducibility	G	E	G	P	P	P	VP
	Half tone uniformity	E	G	E	M	M	P	VP
After continuous printing 100,000-sheet	Image density	E	E	G	M	M	M	P
	Fogging in printed image	E	G	E	M	P	P	VP
	Toner scattering	E	E	G	G	P	M	VP
	Carrier scattering	E	G	M	M	P	P	M
	Horizontal narrow line reproducibility	E	E	M	P	P	P	P
	Half tone uniformity	G	G	G	M	P	P	VP

[0068]

As clarified from Tables, when copy is conducted by using the developer containing the carrier which does not satisfy at least one of the requirements, average particle sizes, surface uniformities, average sphericities and sphericity standard deviations, printed image obtained is poor in image density, fogging in printed image, toner scattering, carrier scattering, horizontal narrow line reproducibility and half tone uniformity. In contrast, when copy is conducted by using the developer which contains the carrier of the present invention, printed image exhibits superior image density, less or no carrier scattering and excellent in horizontal

narrow line reproducibility. In addition, the carrier of the present invention can provide superior durability to the developer to exhibit superior quality at an early period and an elapsed time (after continuous printing of 100,000-sheet) in the printed paper.

【Brief Description of the Drawings】

[0069]

Figure 1 is an illustrative diagram showing a sintering step used in the present invention;

Figure 2 shows an electron microscope photograph (magnification of × 300) of a sintered material obtained by the sintering method of the present invention.

【Description of Symbols】

[0070]

1: granules feeding apparatus

2: rotary kiln

3: hot section

4: heater

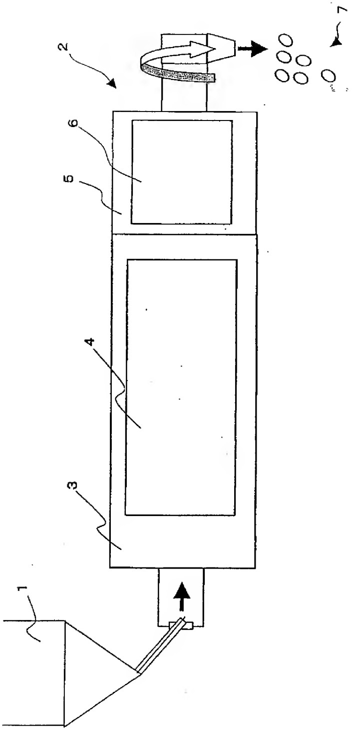
5: cooling section

6: cooling medium

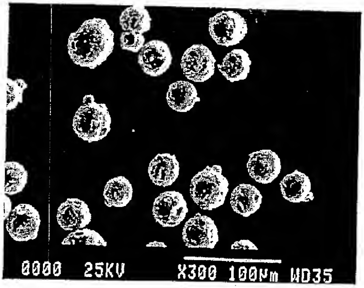
7: sintered material

【Document Name】 Figure

【Figure 1】



【Figure 2】



【Document Name】 Abstract

【Abstract】

【Problem】

To provide a carrier for a developer which can provide elongated life to a developer and a high quality on a photograph and a printed matter, a developer comprising the carrier and a production method of the carrier.

【Means For Solving】

A carrier for a developer characterized by comprising spherical ferrite particles having an average particle size of 20 to 50 μm, a surface uniformity of 90% or more, an average sphericity of 1 to 1.3, and a sphericity standard deviation of 0.15 or less and coated with a organic resin, process for producing a carrier for a developer, the process comprising the sintering of the fluidized ferrite particle performed at a sintering temperature of 1,200°C or more and the coating of an organic resin on the ferrite particles are adopted.

【Chosen drawing】 Figure 1